(5) Determine f_1 of a closed air column $L = 67.5$ cm

$$L = \frac{1}{4}\lambda$$

$$67.5 = \frac{1}{4}\lambda \quad \lambda = 270\text{cm}$$

$$V = \lambda f$$

$$(340) = (2.7\text{m})f$$

$$\boxed{f_1 = 126\text{Hz}}$$

(7) $f_3 = 1100\text{Hz}$

$f_5 = 1833\text{Hz}$

3rd $V = \lambda f$

$340 = \lambda_3(1100)$

$\lambda_3 = .309$

$L = \frac{3}{4}\lambda_3$

$L = \frac{3}{4}(.309)$

5th $V = \lambda f$

$340 = \lambda_5(1833)$

$\lambda_5 = .185$

$L = \frac{5}{4}\lambda_5$

$L = \frac{5}{4}(.185)$

$L = \frac{3}{4}(.309)$

$L \approx 0.232m$

$L = \frac{3}{4}(.309)$

$L = 0.232m$

1st $L = \frac{1}{4}\lambda_1$

$0.232 = \frac{1}{4}\lambda_1$

$\lambda_1 = 0.928m$

$v = \lambda f$

$340 = (.928) f_1$

$f_1 = 366Hz$

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17) 4th $L = 2\lambda$

$85cm = 2\lambda$

$\lambda_4 = 42.5cm$

Speed of vibration of string

$v = \lambda f$

$332 = (0.425) f_4$

$f_4 = 780Hz$

Intensity of a sound wave

- Amount of energy transported past a given area of the medium per unit of time
- Watts/m^2

$$\text{Intensity} = \frac{\text{Energy}}{\text{Time} * \text{Area}} \quad \text{or} \quad \text{Intensity} = \frac{\text{Power}}{\text{Area}}$$

Sound level/Decibels

- The threshold of hearing is assigned a sound level of 0 decibels (abbreviated 0 dB); this sound corresponds to an intensity of 1*

10^{-12} W/m^2

- Scale based on powers of 10
- A sound that is 10 times more intense (1* 10^{-11} W/m^2) is assigned a sound level of 10 dB.
- A sound that is 10*10 or 100 times more intense (1*10^{-10} W/m^2) is assigned a sound level of 20 db.
- A sound that is 10*10*10 or 1000 times more intense (1*10^{-9} W/m^2) is assigned a sound level of 30 db.
- A sound that is 10*10*10*10 or 10000 times more intense (1*10^{-8} W/m^2) is assigned a sound level of 40 db.

Source	Intensity	Intensity Level	# of Times Greater Than TOH
Threshold of Hearing (TOH)	1*10^{-12} W/m^2	0 dB	10^0
Rustling Leaves	1*10^{-11} W/m^2	10 dB	10^1
Whisper	1*10^{-10} W/m^2	20 dB	10^2
Normal Conversation	1*10^{-6} W/m^2	60 dB	10^6
Busy Street Traffic	1*10^{-5} W/m^2	70 dB	10^7
Vacuum Cleaner	1*10^{-4} W/m^2	80 dB	10^8
Large Orchestra	6.3*10^{-3} W/m^2	98 dB	$10^{9.8}$
Walkman at Maximum Level	1*10^{-2} W/m^2	100 dB	10^{10}
Front Rows of Rock Concert	1*10^{-1} W/m^2	110 dB	10^{11}
Threshold of Pain	1*10^{1} W/m^2	130 dB	10^{13}
Military Jet Takeoff	1*10^{2} W/m^2	140 dB	10^{14}
Instant Perforation of Eardrum	1*10^{4} W/m^2	160 dB	10^{16}

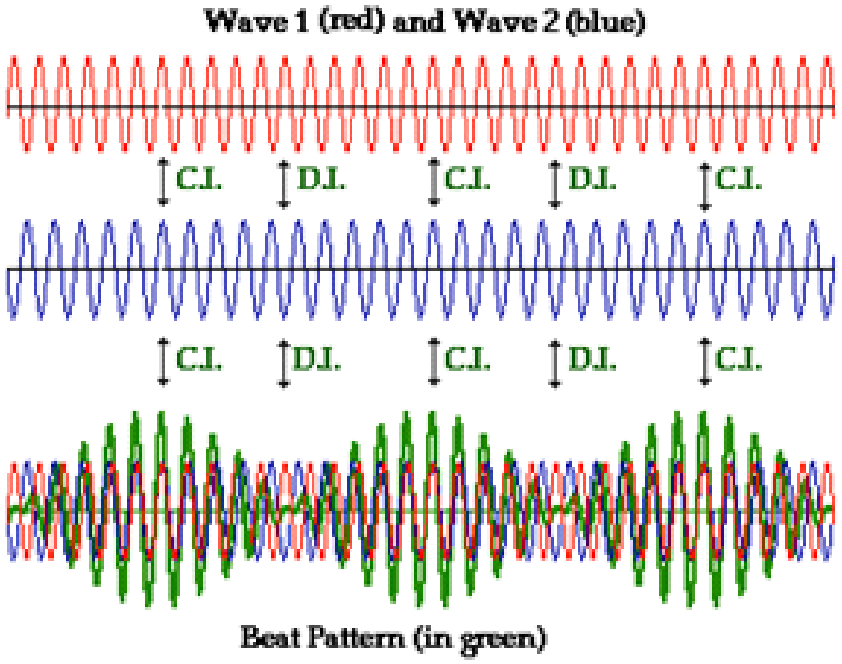
octave - any two sounds whose frequencies make a 2:1 ratio are said to be separated by an **octave**

Interval	Frequency Ratio	Examples
Octave	2:1	512 Hz and 256 Hz
Third	5:4	320 Hz and 256 Hz
Fourth	4:3	342 Hz and 256 Hz
Fifth	3:2	384 Hz and 256 Hz

Example:
Two musical notes that have a frequency ratio of 2:1 are said to be separated by an octave. A musical note that is separated by an octave from middle C (256 Hz) has a frequency of: 128 Hz

Beats

- **Beats** are the periodic and repeating fluctuations heard in the intensity of a sound when two sound waves of very similar frequencies interfere with one another.



- beat frequency
  - rate at which the volume is heard to be oscillating from high to low volume
  - For example, if two complete cycles of high and low volumes are heard every second, the beat frequency is 2 Hz.
  - The beat frequency is always equal to the difference in frequency of the two notes that interfere to produce the beats.

- Longer Beats video: https://www.youtube.com/watch?v=8vUuGRaTQ2E
- Shorter Beats video:
- https://www.youtube.com/watch?v=dD9gtq08tss

consonance (pleasing sounds)
dissonance (unpleasant sounds)